UNITIZED PINION SEAL FOR AN AXLE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/463,293, filed on April 16, 2003. The disclosure of the above application is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates in general to seals and more particularly to a pinion seal used to seal about an axle pinion.

BACKGROUND OF THE INVENTION

During assembly of an axle, a pinion seal is assembled between an axle companion flange and a carrier/bearing cage. The pinion seal includes a sleeve portion, which is mounted to and rotates with the axle companion flange, and a seal portion, which is mounted to and is stationary with the carrier/bearing cage. The two end up, then, in sliding engagement at seal contact locations. This requires an axial spacing between certain portions of the two components to assure that the only contact is at the seal contact locations. Thus, in order to accomplish the proper installation of the sleeve portion and seal portion, a contacting spacer is typically employed between the sleeve and the seal. This is particularly true if one attempts to assemble the two portions as a single unit. However, a contacting spacer located between the seal and sleeve components will generally cause higher torque loss, additional noise, and increased heat generation due to the additional friction between components.

Also, during assembly, since the sleeve portion and the seal portion are typically assembled separately, this may allow contamination to enter the seal. Consequently, it is desirable to have a unitized seal where the two portions can be assembled as one. Being able to assemble the pinion seal as a unitized assembly would also be desirable in order to improve the assembly process.

Thus, it is desirable to have a unitized pinion seal for axle pinion applications that can be assembled as a unit and have a bearing configuration suitable for supporting and spacing the stationary (seal) and rotating (sleeve) components during assembly of the axle.

SUMMARY OF THE INVENTION

In its embodiments, the present invention contemplates a unitized pinion seal as shown and described herein.

The present invention further contemplates a method of assembling a unitized pinion seal to a carrier/bearing cage and an axle companion flange as shown and described herein.

An advantage of an embodiment of the present invention is that the unitized seal design will shield the critical areas of the seal during installation, which minimizes the chance for receiving contamination in or damage to critical areas of the seal. Moreover, by shielding the critical areas of the seal, a ground surface finish for the mating components may not be required.

Another advantage of an embodiment of the present invention is that the unitized design allows for assembly of both portions of the seal simultaneously without requiring a contact spacer to be mounted between the seal and sleeve components. The elimination of the spacer will reduce torque loss, minimize the noise, and decrease heat generation by reducing the friction between components. Yet, when assembled onto the axle, the seal allows for the required axial spacing between the rotating and stationary portions of the seal

A further advantage of an embodiment of the present invention is that the assembly of the unitized design, without spacers, does not require special assembly methods in order to provide the required spacing between components.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a cross sectional view of a pinion seal assembly according to the principles of the present invention, installed in a carrier/bearing cage bore, but before assembly onto an axle flange;

Figure 2 is a view similar to Figure 1 but illustrating the pinion seal assembly as it begins to be installed on the axle flange;

Figure 3 is a view similar to Figure 2, but illustrating the pinion seal assembly assembled further onto the axle flange;

Figure 4 is a view similar to Figure 3, but illustrating the pinion seal assembly completely assembled onto the axle flange;

Figure 5 is a cross-section of a second embodiment of the pinion seal assembly according to the principles of the present invention;

Figure 6 is a cross-section of the pinion seal of Figure 5 shown in a fully assembled condition;

Figure 7 is a cross-section of a third embodiment of the pinion seal assembly according to the principles of the present invention; and

Figure 8 is a cross-section of a fourth embodiment of the pinion seal assembly according to the principles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

With reference to Figures 1-4, a pinion seal assembly 10 is shown at four different stages of being assembled to a carrier/bearing cage 12 and a companion flange 14 of an axle 16 (Fig. 2). The pinion seal assembly 10 is preassembled and includes a sleeve portion 18 slidably engaging a seal portion 20 and a first retainer ring 22. A second retainer ring 24 engages a shoulder 26 on the carrier/bearing cage 12 and engages the first retainer ring 22 as well as the seal portion 20. The pinion seal assembly 10 is preassembled with the sleeve portion 18, seal portion 20, first retainer ring 22, and second retainer ring 24 all engaged as will be described in greater detail herein. The preassembly is done prior to installation of the pinion seal assembly 10 onto the axle 16. Since the components of the pinion seal assembly 10 are already assembled, the internal area between the sleeve portion 18 and seal portion 20 including seal lips 28, 30, 32 will not be exposed during assembly on the axle 16. Thus, the chance of contaminants entering or interfering with the seal lips 28, 30, 32 is greatly reduced.

The sleeve portion 18 is ring shaped with a generally J-shaped cross-section having a first axially extending ring portion 18A, a radially extending ring portion 18B,

and a second axially extending ring portion 18C. The first axially extending ring portion 18A and radially extending ring portion 18B are covered with an elastomeric seal layer 34 including a pair of raised rib portion 36, 38. An outer surface of the first axially extending ring portion 18A of sleeve portion 18 includes a first portion 18A' having a first predetermined diameter and a second rearward portion 18A'' having a larger diameter than the forward portion 18A' with a ramp portion 18A''' being disposed therebetween. It should be understood that other configurations of the sleeve can be utilized. The seal rings 36, 38 of the sleeve portion 18 are adapted to engage the companion flange 14 of the axle 16 in the assembled condition.

The seal portion 20 is provided with the first, second, and third seal lips 28, 30, 32. The seal portion 20 has a recessed region 40 disposed in the vicinity of the first seal lip 28. The recessed portion 40 is adapted to receive a garter spring 42 therein for applying a radially inward force to the seal portion 20. The seal portion 20 includes a body portion 44 which engages a first radially inwardly extending flange portion 24A of the second retainer ring 24. The second retainer ring 24 includes a second axially extending ring portion 24B and a third radially outwardly extending flange portion 24C which has an end portion 24D which is crimped around a radially outwardly extending flange portion 22A of the first retainer ring 22. The first retainer ring 22 also includes an axially extending ring portion 22B having an inner diameter surface which engages the second axially extending ring portion 18C of sleeve portion 18. The first retainer ring 22 includes a radially inwardly extending flange portion 22C which engages the radially extending ring portion 18B of sleeve portion 18 as illustrated in Figures 1-3.

With reference to Figure 2, the pinion seal assembly 10 is inserted into a bore 46 such that the seal portion 20 and axially extending ring portion 24B of the second retainer ring 24 are received in and engage the bore 46. The radially outwardly extending flange portion 24C of the second retainer ring 24 engages shoulder 26 of carrier/bearing cage. As shown in Figure 2, the axle companion flange 14 of axle 16 is inserted into the sleeve portion 18, with the inner diameter of the elastomeric seal 38 initially sliding along the companion flange 14 without an interference fit (as best seen in Figure 2). With further insertion of the companion flange 14, a radial interference begins to develop between the companion flange 14 and the elastomeric seal 38. The seal 38 and sleeve portion 18 are sized and shaped so that a radial interference condition develops between the seal 38 and the companion flange 14 as the companion flange 14 slides farther into the sleeve portion

18. The interference condition between the sleeve portion 18 and the companion flange 14 might be designed to occur at any location on the flange 14, or any other component that is assembled to it that is stationery with respect to the flange 14, such as a flange deflector. With further insertion of the companion flange 14, an axial interference condition develops between a deflector 48 and the sleeve 18 (the sleeve abuts the deflector). The axial interference condition between the sleeve 18 may be designed to occur at any location on the deflector 48, flange 14, or any other component that is assembled to and is stationary with respect to the flange 14. The axial interference condition developed prevents further sliding motion between the sleeve 18 and companion flange 14 and is designed to occur before the companion flange 14 abuts the bearing 50. Further installation of the companion flange 14 then causes the sleeve 18 to disengage the first assembly ring 22 before the companion flange 14 reaches the final assembled position, abutting bearing 50 (best seen in Figure 4).

The deflector 48 is provided on axle 16 and eventually abuts against the radially extending ring portion 18B of sleeve portion 18, as best seen in Figure 3. The final radial interference fit, after being fully installed, holds the sleeve portion 18 stationary relative to the companion flange 14 during operation of the axle 16.

The axial retention level due to the press fit of the sleeve portion 18 onto the first retainer ring 22 is preferably greater than the axial installation load created when the axle companion flange 14 is inserted through the inner diameter of the sleeve portion 18. As a result, the seal portion 20 remains generally stationary relative to the sleeve portion 18 during the initial part of the installation.

In the completed assembly, the companion flange 14 is fully assembled relative to the carrier/bearing cage 12, with the second retainer ring 24 fully assembled to the carrier/bearing cage 12 and the sleeve portion 18 fully assembled to the companion flange 14 of axle 16 such that a proper axial spacing exists between the seal portion 20 and the sleeve portion 18. During operation, the sleeve portion 18 can rotate with the companion flange 14, while the seal portion 20 remains stationary with the carrier/bearing cage 12, with the only contact between the two being sealing lips 28, 30, 32. Thus, the proper sealing is assured while minimizing the friction between the two portions of the pinion seal assembly 10.

Figures 5 and 6 illustrate an alternate embodiment of the pinion seal assembly 110. In this embodiment, the sleeve portion 118 is modified to include a radially

outwardly extending flange 120 extending from the second axially extending ring portion 118 such that the flange portion 120 engages the first retainer ring 122. In this embodiment, the first retainer ring 122 does not include a radially inwardly extending flange portion such as radially inwardly extending flange portion 22C of the first retainer ring 22 disposed in the embodiment shown in Figures 1-4. In addition, the shape of the second retaining ring 124 has also been changed in order to demonstrate the differing configurations that can be utilized. As illustrated in Figure 6, the pinion seal assembly 110 is shown in a fully assembled condition such that the sleeve portion 118 is moved axially relative to the seal portion 20. Although the shape and configuration of some of the components are different, the installation process and resulting axial spacing for the pinion seal assembly 110 are the same as in the first embodiment as described above with reference to Figures 1-4.

With reference to Figure 7, an additional alternative embodiment of the pinion seal assembly 210 is shown. In this embodiment, the pinion seal assembly 210 includes a separate component 212 that supports the sleeve portion 218 during the initial phase of the installation. After the axial interference condition between the sleeve portions 218 and companion flange (not shown in Figure 7) develops, the separate component 212 preferably disengages from the first retainer ring 222 or sleeve portion 218 due to the further axial motion of the companion flange. The component 212 then becomes spaced from the portion from which it separated, which can be due to gravity, springs, separation of press-fit components, or similar means.

With reference to Figure 8, a fourth embodiment of the pinion seal assembly 310 is provided. In this embodiment, the pinion seal assembly 310 includes a separate component 312 that supports the sleeve portion 318 during the initial phase of the installation. After the axial interference condition between the sleeve portion 318 and companion flange (not shown) develops, the separate component 312 preferably disengages from either the first retainer ring 322 or sleeve portion 318 due to the further axial motion of the companion flange. The component 312 then becomes spaced from the portion from which it separated, which can be due to gravity, springs, separation of press-fit components or similar means.

The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the

scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.